Inducing Universal Access to Privately Managed Social Interest Goods via Location Decisions

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Research fields

- Economics, Industrial Organization
  - Competition
  - Regulation
- Location
- Effects of the location choice on
  - Competition
  - Prices
  - Level of provision
  - Welfare

Outline

1) Introduction
2) Analytical approach
3) Problem formulation
4) Analytical insights

Introduction

- Universal service obligations (e.g. public utilities, Laffont and Tirole (2000))
  - Universal access / full coverage
  - Uniform prices (no price discrimination)
- Nature of decision
  - Economic (network effects)
  - Political
    - Redistribution: consumers with low income, remote location or limited geographical mobility
    - Regional planning: limit congestion, maintain rural habitat

Introduction

- On-site services
  - Health care, education, community services
  - Mill pricing
  - Transport costs → paid by the consumer
- Home-delivered services
  - Electricity, gas, water, postal services
  - Most often natural monopolies
  - Delivered pricing
  - Transport costs → paid by the provider
- Uniform prices
  - Price discrimination, often unpopular (e.g. British Gas, 1998)
  - Uniform mill prices (on-site services)
  - Uniform delivered prices (home-delivered services)

Related literature

- **Operations research → universal acces through location** (covering problems, no price analysis)
  - Education centres: Bruno and Anderson (1982); Diamond and Wright (1987); Church and Murray (1993); Malczewski and Kackson (2000); Ewing et al. (2004); Pal (2010)
  - Health and emergency services: Marianov and ReVelle (1995); Daskin and Dean (2005); Günes and Nickel (2015)
- **Economics**
  - **Universal service obligations**: Laffont and Tirole (2000) (telecommunications); Armstrong (2008) (postal services)
  - **Privatization of monopoly utilities**: Wright (1987) (British Gas)
  - **Monopoly regulation** (regulated price, subsidies): Hotelling (1938) (railway); Stigler and Friedland (1962) (electricity); Lyon (1994) (telecommunications)

Analytical approach

- Theoretical model of spatial monopoly
- Interest of public sector: provision, adequate prices
- Monopoly: simplify the analysis of regulation
- Spatial approach: provision and price discrimination regarding location of consumers
- Firm
  - Private: maximise profits
  - Public: maximise social welfare
- Universal service obligations
  - Full provision
  - Uniform prices: mill prices, delivered prices
- Two decisions: location and prices

Analytical approach

Our work builds on the contributions of:

- Hotelling (1929): customer location on a straight line; two firms located along the line; no price discrimination;
- Hwang and Mai (1990): population concentrated in two urban areas with an uninhabited connecting motorway; monopolist's location either along the line or in one of the urban areas; price discrimination between cities $\rightarrow$ barbell model

Analytical approach

Assumptions

- One plant to be open (located at x, $0 \leq x \leq 1$)
- Two markets: 1 ($x_1 = 0$), 2 ($x_2 = 1$)
- Mass of consumers (consumer density): M_1, M_2
- Reservation price: v
- Linear transportation costs, no costs of production
- Prices: p_1, p_2
- Full provision if $v > max\{p_1 + t\text{x}, p_2 + t(1 - x)\}$
- Market 1 is more populated: $M_1 > M_2$

Analytical approach

- Decisions
  - 1st → level of provision: $q = \{M_1, M_1 + M_2\}$
  - 2nd → location: x
  - 3rd → prices: p_1, p_2
- Solved by backward induction
- Nature of the firm:
  - Private (max profits)
  - Public (max social welfare)
- Cases
  - Unregulated monopoly
  - USO through uniform mill prices: $p_1 = p_2$
  - USO through uniform delivered prices:

$$p_1 + tx = p_2 + t(1 - x)$$

Private monopoly

1) Unregulated monopoly
   - 1st → level of provision: $q = \{M_1, M_1 + M_2\}$ (max π)
   - 2nd → location: x (max π)
   - 3rd → prices: p_1, p_2 (max π)
2) USO through uniform mill prices
   - 1st → level of provision: $q = M_1 + M_2$
   - 2nd → location: x (max π)
   - 3rd → prices: p_1, p_2 (max π), s.t. $p_1 = p_2$
3) USO through uniform delivered prices
   - 1st → level of provision: $q = M_1 + M_2$
   - 2nd → location: x (max π)
   - 3rd → prices: p_1, p_2 (max π), s.t. $p_1 + tx = p_2 + t(1 - x)$

Private monopoly

1) Unregulated monopoly
   - $1^{st} \rightarrow$ level of provision: $q = \{M_1, M_1 + M_2\}$ (max π)
   - $2^{nd} \rightarrow$ location: x (max π)
   - $3^{rd} \rightarrow$ prices: p_1, p_2 (max π)

- Partial provision
  - $\pi = p_1 M_1$
  - $CS = (v - p_1 - tx)M_1$
    - $x = 0$, $p_1 = v$
- Full provision
  - $\pi = p_1 M_1 + p_2 M_2$
  - $CS = (v - p_1 - tx)M_1 + [v - p_2 - t(1 - x)]M_2$
    - $p_1 = v - tx$, $p_2 = v - t(1 - x)$
    - $\pi = (v - tx)M_1 + [v - t(1 - x)]M_2 \rightarrow x = 0$

Private monopoly

1) Unregulated monopoly

$$\begin{cases} x = 0 \\ q = M_1 + M_2 \\ p_1 = v \\ p_2 = v - t \\ \pi = vM_1 + (v - t)M_2 \\ CS = 0 \\ SS = vM_1 + (v - t)M_2 \end{cases} \quad \text{when } v \geq t,$$

$$\begin{cases} x = 0 \\ q = M_1 \\ p_1 = v \\ \pi = vM_1 \\ CS = 0 \\ SS = vM_1 \end{cases} \quad \text{when } v < t$$

Private monopoly

2) USO through uniform mill prices
- 1st $\rightarrow$ level of provision: $q = M_1 + M_2$
- 2nd $\rightarrow$ location: x (max π)
- 3rd $\rightarrow$ prices: p_1, p_2 (max π), s.t. $p_1 = p_2$

$$\begin{cases} x = \frac{1}{2} \\ q = M_1 + M_2 \\ p_1 = v - \frac{t}{2} \\ p_2 = v - \frac{t}{2} \\ \pi = \left(v - \frac{t}{2}\right)(M_1 + M_2) \\ CS = 0 \\ SS = \left(v - \frac{t}{2}\right)(M_1 + M_2) \end{cases} \quad \text{when } v \geq \frac{t}{2}.$$

For any value $v < \frac{t}{2}$, universal provision is not feasible.

Private monopoly

3) USO through uniform delivered prices
- 1^{st} → level of provision: $q = M_1 + M_2$
- 2^{nd} → location: x (max π)
- 3^{rd} → prices: p_1, p_2 (max π), s.t. $p_1 + tx = p_2 + t(1-x)$

$$\begin{cases} x = 0 \\ q = M_1 + M_2 \\ p = v \\ \pi = vM_1 + (v-t)M_2 \\ CS = 0 \\ SS = vM_1 + (v-t)M_2 \end{cases} \quad \text{when } v \geq t\frac{M_2}{M_1+M_2}.$$

For any value $v < t\frac{M_2}{M_1+M_2}$, universal provision is not profitable for the firm at any location.

Public monopoly

1) Unregulated monopoly
   - 1st → level of provision: $q = \{M_1, M_1 + M_2\}$ (max SS)
   - 2nd → location: x (max SS)
   - 3rd → prices: p_1, p_2 (max CS)
2) USO through uniform mill prices
   - 1st → level of provision: $q = M_1 + M_2$
   - 2nd → location: x (max SS)
   - 3rd → prices: p_1, p_2 (max CS), s.t. $p_1 = p_2$
3) USO through uniform delivered prices
   - 1st → level of provision: $q = M_1 + M_2$
   - 2nd → location: x (max SS)
   - 3rd → prices: p_1, p_2 (max CS), s.t. $p_1 + tx = p_2 + t(1 - x)$

Public monopoly

1) Unregulated monopoly
   - 1st → level of provision: $q = \{M_1, M_1 + M_2\}$ (max SS)
   - 2nd → location: x (max SS)
   - 3rd → prices: p_1, p_2 (max CS)

- Partial provision
  - $CS = (v - p_1 - tx)M_1, SS = (v - tx)M_1$
    - $x = 0, p_1 = 0$
- Full provision
  - $CS = (v - p_1 - tx)M_1 + [v - p_2 - t(1 - x)]M_2$
  - $SS = (v - tx)M_1 + [v - t(1 - x)]M_2$
    - $p_1 = 0, p_2 = 0, x = 0$

Public monopoly

1) Unregulated monopoly

$$\begin{cases} x = 0 \\ q = M_1 + M_2 \\ p_1 = 0 \\ p_2 = 0 \\ \pi = 0 \\ CS = vM_1 + (v - t)M_2 \\ SS = vM_1 + (v - t)M_2 \end{cases} \quad \text{when } v \geq t, \qquad \begin{cases} x = 0 \\ q = M_1 \\ p_1 = 0 \\ \pi = 0 \\ CS = vM_1 \\ SS = vM_1 \end{cases} \quad \text{when } v < t$$

Public monopoly

2) USO through uniform mill prices
- 1st → level of provision: $q = M_1 + M_2$
- 2nd → location: x (max SS)
- 3rd → prices: p_1, p_2 (max CS), s.t. $p_1 = p_2$

$$\begin{cases} x = 0 \\ q = M_1 + M_2 \\ p_1 = 0 \\ p_2 = 0 \\ \pi = 0 \\ CS = vM_1 + (v-t)M_2 \\ SS = vM_1 + (v-t)M_2 \end{cases} \quad \text{when } v \geq t, \qquad \begin{cases} x = 1 - \frac{v}{t} \\ q = M_1 + M_2 \\ p_1 = 0 \\ p_2 = 0 \\ \pi = 0 \\ CS = (2v-t)M_1 \\ SS = (2v-t)M_1 \end{cases} \quad \text{when } \frac{t}{2} \leq v < t.$$

For any value $v < \frac{t}{2}$, universal provision is not feasible.

Public monopoly

3) USO through uniform delivered prices
- 1st → level of provision: $q = M_1 + M_2$
- 2nd → location: x (max SS)
- 3rd → prices: p_1, p_2 (max CS), s.t. $p_1 + tx = p_2 + t(1 - x)$

$$\begin{cases} x = 0 \\ q = M_1 + M_2 \\ p = t \\ \pi = tM_1 \\ CS = (v - t)(M_1 + M_2) \\ SS = vM_1 + (v - t)M_2 \end{cases} \text{when } v \geq t, \qquad \begin{cases} x = 1 - \frac{v}{t} \\ q = M_1 + M_2 \\ p = t \\ \pi = (2v - t)M_1 \\ CS = 0 \\ SS = (2v - t)M_1 \end{cases} \text{when } \frac{t}{2} \leq v < t.$$

For any value $v < \frac{t}{2}$, universal provision is not feasible.

Conclusions

- Without USO, partial provision if $v < t$
- Unregulated private monopoly, consumers from the remote market pay a lower mill price $\rightarrow$ spatial price discrimination (subsidized for their journey)
- Private monopoly subject to USO on uniform delivered prices, consumers from the remote market pay a negative mill price (cross-subsidization) when $t\frac{M_2}{M_1+M_2} \leq v < \frac{t}{2}$
- Imposing USO increases the number of users but not the efficiency (SS and CS do not increase) $\rightarrow$ USO is not economically efficient (political decision)